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Abstract
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The ESA CaRMA Campaign: An Overview Of The Acquired Data

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Challenge, Methodology and data

Research efforts aiming at monitoring soil and vegetation dynamics in the field are significant for remote sensing applications. However, these efforts are often restricted by logistical, financial and personal limitations resulting in missing cross-institutional collaborations. In preparation of the hyperspectral CHIME mission, the European Space Agency (ESA) has initiated a large campaign between April 2025 and October 2025 in the agricultural area of Puch, West of Munich, Germany. The agricultural landscape is characterized by a mosaic of cultivated fields, grassland parcels and scattered tree- and hedge structures. Vegetation is dominated by crop species typical of temperate Central European farming systems, including cereals such as corn, summer/winter wheat, barley, triticale as well as maize and rapeseed.

A wide range of optical instruments such as hyperspectral satellite, multisensorial airborne and UAV based high-resolution RGB data acquisitions have been acquired together with frequent in situ measurements characterising soil and vegetation by the team of the LMU. Contemporaneously, the high-performance aircraft-based radar system F-SAR was deployed to provide data in preparation for the RADAR mission ROSE-L.

Effective implementation of remote sensing campaigns requires close coordination among multiple operational and institutional partners. In this context, the synchronization of data acquisition activities with ASI (PRISMA), Teledyne (DESIS) and DLRs EnMAP ground segment was essential to ensure optimal temporal resolution. Between 1st of April 2025 and 31st of Oct 2025, overall, 35 cloud free hyperspectral datasets from DESIS, PRISMA and EnMAP could be recorded resulting in one acquisition on average every ~6 days. Similarly, the coordination of airborne HySpex (DLR), HyPlant (CzechGlobe) overpasses for recording complementary hyperspectral, fluorescence and thermal observations under comparable conditions enhances the scalability and validation activities. In total, six airborne hyperspectral flights were successfully conducted. Five out of six overpasses were planned (North to South) to align with synchronous hyperspectral satellite overpasses. One acquisition was addressed to the effects of bidirectional reflectance distribution function (BRDF) with an adjusted flight strategy. UAV airborne data was collected by DLR a) with a user-friendly consumer UAV (RGB) on a weekly basis resulting in nearly 15.000 high resolution RGB images and b) by GFZ with a UAV carrying and hyperspectral HySpex & LIDAR setup. In-situ data include overall two soil sampling data sets acquired by DLR and GFZ aiming to derive SOC, pH, texture and other key soil parameters. Microtops measurements for atmospheric characterization (DLR), and weekly sampling of vegetation traits like Leaf-Area-Index (LAI), Aboveground Dry Biomass, Canopy Nitrogen Content and Canopy Carbon Content for respectively leaf, stem and fruit by LMU to support the calibration and validation for remote sensing methodologies.

Discussion and Conclusions

The campaign was designed to synchronize multiple platforms and sensors across different spatial and spectral scales for high- precision environmental monitoring. Together, these combined datasets support the development of more precise and comprehensive environmental analyses. The temporal resolution of approximately ~6 days for hyperspectral satellite imagery allows scientists to track vegetation and soil dynamics, couple complementary hyperspectral airborne and situ data to develop and validate methodologies at the same time. Together, this comprehensive dataset will enable detailed assessment of biophysical and biochemical processes, facilitate cross-sensor harmonization, and strengthen the validation of remote sensing products across platforms.

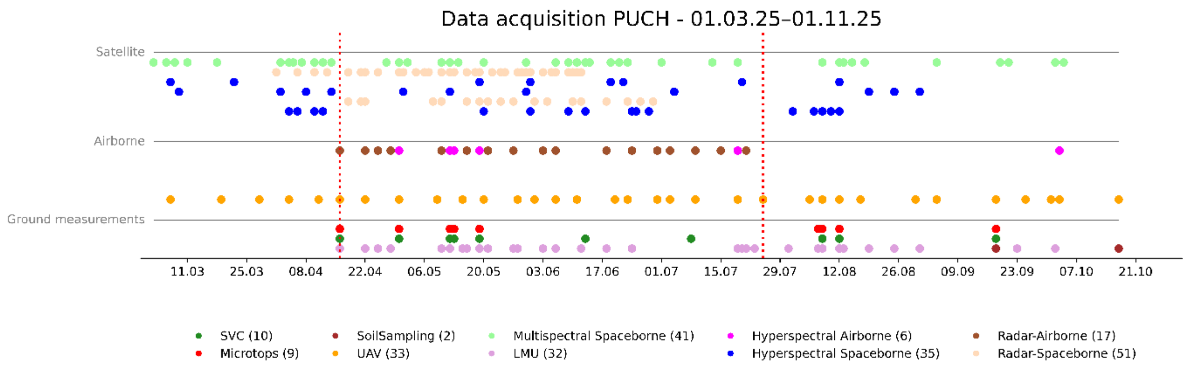

Figure 1: A schematic overview of the data acquired during the CaRMA campaign in Puch. The dashed red line marks the core period of the campaign.